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by

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On 11 November 1981, the *USS Ohio* (SSBN-726) was commissioned. The first of the new Trident submarines, *Ohio* is the product of years of research, development, controversy, and hard work. Yet *Ohio* is but one part of a total Trident System which includes ships and missiles, logistic support plans, training, and basing modes.

This treatise will analyze the two major aspects of the US Trident System: *Ohio*-class submarines and Trident missiles. The major issues in their development will be considered as will alternatives to each. Finally, prospects for the future will be examined based on the new realities of strategic nuclear force employment in a potential conflict. The impact of the Trident System on both the US Navy and this nation's strategic nuclear capabilities is potentially so profound that it could fundamentally restructure the long-held triad of land-based missiles, manned bombers, and the submarine ballistic missile force.

The *Ohio*-Class Submarine

The *Ohio*-class nuclear-powered ballistic missile submarine (SSBN) is the largest submersible ever constructed by the United States. *Ohio* is 560 ft. long, 42 ft. wide, and displaces 18,700 tons submerged. It can accommodate 164 personnel but will normally be manned by two alternating (Blue/Gold) crews of 15 officers and 142 enlisted men. Each *Ohio* will have 24 missile tubes and 4 torpedo tubes. The submarine was built by Electric Boat, a subsidiary of General Dynamics, in Groton, Connecticut.

The building of a new SSBN stems from the extensive STRAT-X study commissioned by Secretary of Defense Robert McNamara in 1966.[1] STRAT-X was to determine if the United States needed a new advanced intercontinental ballistic missile (ICBM) and if so, how it was to be based. Nine possible systems were analyzed including land, surface ship, and submarine-based alternatives. Over 100 various combinations of submarine-launched ballistic missiles (SLBMs) on differing submarines were considered.

STRAT-X recommended in 1967 four possible options. From these, the Office of the Secretary of Defense (OSD) favored a plan for an Underwater Long-Ranged Missile System (ULMS). ULMS was a logical choice since the Navy's Polaris/Poseidon

sea-based strategic forces were designed for 20-25 years of operational life and would need to be replaced starting in 1979.[2]

ULMS submarines were to carry their missiles externally. When the plans for this type missile were revised around 1971, submarine developments were shifted to a new larger SSBN capable of carrying very long-range missiles internally. The determinants of the submarine size were the size and number of missile tubes and the size of the nuclear reactor. Missile tube size was predicated on a future missile which would meet ULMS range goals. The sub, therefore, had to be bigger than Polaris or Poseidon. The number of missile tubes per ship was a variable, with 16-24 being considered. Reactor size was finally decided to be 60,000 horsepower, almost twice the power of that to be installed on the *Los Angeles* (SSN-688) class nuclear attack submarine (SSN).[3]

Inputs to *Ohio*'s design came from VAdm. Hyman G. Rickover (reactor), RAdm. Levering Smith's Special Projects Office (missile), and Adm. Elmo R. Zumwalt, Jr., the Chief of Naval Operations. OSD systems analysts are credited with demonstrating the cost effectiveness of 24 missile tubes to both Admiral Zumwalt and Defense Secretary Melvin Laird.[4] Construction approval was obtained in the fall of 1973 largely due to the sales efforts of Secretary Laird and Admiral Zumwalt.[5]

The building of the *Ohio* class submarine has been fraught with controversy. Notwithstanding these problems, construction contracts for the ninth *Ohio*-class SSBN have now been completed. Table 1 outlines the authorized and funded *Ohio*-classs building program with the latest estimates of delivery date to the Navy.[6]

Table 1. Fnnded *Ohio* Class Construction Program

Name	Hull Number	Launched	Delivery Date	% Complete
Ohio	SSBN-726	7 Apr 79	28 Oct 81	100
Michigan	SSBN-727	26 Apr 80	30 Sep 82	100
Florida	SSBN-728	14 Nov 81	30 Jun 83	83.2
Georgia	SSBN-729	6 Nov 82	29 Feb 84	63.1
Rhode Island	SSBN-730		31 Oct 84	48
Alabama	SSBN-731		29 Jun 85	36.2
	SSBN-732		28 Feb 86	23.6
	SSBN-733		31 Oct 86	9.5
	SSBN-734		Dec 87	

Source: *Navy Times* (November 1981) updated by news releases

Funding for a tenth and eleventh *Ohio*-class SSBN was requested in the FY-83 budget. The January 1982 Five Year Defense Plan calls for purchase of long lead items for an additional 4 submarines. The total number of *Ohio*-class submarines has yet to be announced but will at least be fifteen. Deliveries of the nine funded SSBNs should now occur as depicted in Table 2 by the end of each fiscal year.

Deliveries of *Ohio*-class SSBNs are being paralleled by changes in older Polaris-equipped *George Washington* and *Ethan Allen* class submarines. Initially, 2 of these units were decommissioned to keep within the SLBM launcher limit specified by the

Table 2. *Ohio*-Class Delivery Schedule

	FY82	FY83	FY84	FY85	FY86	FY87	FY88	FY89
Subs Delivered	2	1	1	2	1	1	1	1
Total Delivered	2	3	5	6	8	9	10	11

Source: FY-83 Arms Control Impact Statements

Interim Agreement negotiated as part of the Strategic Arms Limitations Talks (SALT I). It was decided that since these 10 older SSBNs could not be backfitted with Poseidon or Trident missiles, their launchers should be traded in so as to remain within SALT I guidelines.

These submarines did not warrant the costly upkeep that would result from keeping the Polaris program open. The amount of damage their missiles could produce and their total contribution to national capability was also shown to be not worth manpower and training costs. Hence, the first two units were decommissioned and eight others are supposed to be converted to SSNs. The 13th *Ohio* class will place the United States at the maximum SALT I limit of 44 SSBNs. The eight older SSBNs being converted to SSNs will continue to be SALT I accountable until they have been satisfactorily modified and can no longer function as SSBNs. This may require their total scrapping.

Tbe *Ohio*-class submarine has been promoted as having numerous advantages over earlier SSBNs. The main benefits appear to be cost effectiveness and survivability. In the former category, the biggest impact appears to be the large number of missiles/warheads carried and the Trident Integrated Logistics Support (ILS) Plan. *Ohio* patrols will be longer, refits and overhauls shorter, and time between refits, refueling and overhauls much longer tban on earlier SSBNs. When coupled with a greater number of launchers per hull, the result will be a higher operational availability for submarines and more warheads on patrol with fewer submarines. Table 3 summarizes these factors.[7]

Table 3. Impact of Trident ILS Plan

	Ohio Class Capability	Previous Poseidon Capability
Patrol Duration (days)	70	68
Post-patrol refit (days)	25	32
Extended refit (days)	Not required	62
Extended refit cycle	Not applicable	After 11 patrols
Major overhaul (months)	12	19
Major overhaul cycle	After 34 patrols	After 33 patrols
Net operational availability	66%	55%

Source: General Accounting Office

Ohio-class submarines will have improved standards of organizational level maintenance due to self-diagnostic, modular, and standardized equipment, larger passageways and access hatches, progressive refurbishment of piping and equipment, and a specially designed supporting supply system. The cycle between major overhauls for *Ohio* is expected to be nine years with no minor upkeep periods in between. This should result in lower cost per equivalent numbers of warheads on patrol compared to the previous SSBN patrol capability.

As for survivability, *Ohio* has a quieter S8G nuclear reactor, double shock mounting on most major components, new equipment designed with quietness built in. *Ohio* can patrol at faster speeds while remaining at current levels of radiated noise and has the ability to increase to higher speeds than can current SSBNs, if needed for evasion. *Ohio* also incorporates a modified version of the successful sonar system carried aboard the latest SSN, the *Los Angeles* (SSN-688) class. All of these improvements to *Ohio* plus the advantage of the increased ranges for Trident I missiles make her less likely to ever become susceptible to long-term improvements in Soviet strategic antisubmarine warfare.

There are other very important advantages in the *Ohio*-class submarine. Room has been set aside for growth in electronic areas making it easier to accommodate technological improvements which will undoubdtedly occur with time. The size of the missile tubes is greater than any SLBM currently possessed by the United States. Again, this allows for future growth meaning that only this class of SSBN could handle missiles larger in size or weight than those currently operational. Habitability is another area which received attention and will hopefully pay off with higher retention rates for highly trained nuclear power submarine personnel.

There is a newly designed Integrated Command and Control System which should speed internal communications, decrease reaction times, improve casualty modes of operation, and lessen manning/training requirements. *Ohio* reportedly is capable of launching all her missiles with less than one minute between launches, surfaced or submerged, moving or essentially stationary.[8]

Although the need to replace older Polaris equipped SSBNs now, and Poseidon-equipped submarines as they reach the end of an extended life cycle, is generally conceded, there have been attempts to demonstrate the viability of alternative designs to the *Ohio* hull. These alternatives will be examined later, but it should be said that no scheme devised at this late date could deliver new submarines quicker.

Critics of the *Ohio*-class submarine cite high unit cost, overruns, and delivery delays on the lead ship. Assuming that deliveries and overruns are now controllable since design specifications appear to be final, they center on the cost per submarine. With costs so high, it is argued, sufficient numbers may not be bought. Furthermore, fewer submarines will make our sea-based leg of the Triad prone to a major catastrophe if a significant further advance occurs in Soviet strategic ASW efforts. This argument is paralleled generally by a call for cheaper submarines in greater numbers.

Trident Missiles

The STRAT-X Study, released in 1967, also recommended a new submarine launched missile with a 6,000-mile range. This missile was to be encapsulated and carried externally on a submarine. An alternative missile which could fit into

existing missile tubes in Poseidon-capable SSBNs also began to be discussed and researched. This alternative would bave a 4,000-mile range and be more useful since it could be employed on existing submarines. The 4,000-mile alternative gradually became known as ULMS I and the 6,000 mile encapsulated missile as ULMS II.

The Navy was able to demonstrate that it could make ULMS I operational more rapidly than ULMS II since the latter would require an entirely new type of submarine. Around 1971, the encapsulated ULMS II concept was dropped in favor of retaining missiles within the hull of the submarine. Shortly thereafter, the Trident program was approved by Secretary of Defense Laird. It was to include a new class of traditional SSBNs (later termed the *Ohio* class) to be outfitted with ULMS I missiles (re-termed Trident I). The goal for a longer-range more capable missile was temporarily put off but allowed for in the design of the larger missile tubes in the *Ohio* class.

Funding for both missile and submarine was concurrently provided for in the FY-74 budget. Lockheed Missiles and Space Company was awarded the overall contract for development and production of Trident I in August 1974. Table 4 compares the technical elements and capabilities of Trident I with the Polaris and Poseidon missiles it is replacing.[9]

From the information in Table 4, it is obvious that Trident I gave tbe United States significantly greater range and apparently improved accuracy. Range was obtained by more energetic propellants, a third stage motor, and aerodynamic design. Accuracy was obtained by integrating star sighting and flight path correction into the inertial navigation system during the post-boost phase. [10] Although Trident I meant that fewer reentry vehicles (RVs) would be carried in each warhead, the yield of each RV was greater. The maximum number of RVs which are allowable according to the Treaty on the Limitation of Strategic Offense Arms (SALT II) are for Poseidon fourteen and for Trident I, seven.

Table 4. SLBMs Compared

	Polaris (A3)	Poseidon (C3)	Trident (C4)
Year first deployed	1964	1971	1979
Launch weight (lbs.)	35,000	65,000	65,000+
Height (ft.)	32.32	34.1	34.1
Width (in.)	54	74	74
Maximum Reentry Vehicles (RV)	3	14	8
Normal Number RV carried	3	10	8*
RV Nomenclature	MK-2	MK-3	MK-4
Independently Targetable?	No	Yes	Yes
RV Yield	200 KT	40 KT	100 KT
Warhead Nomenclature	W58	W68	W76
Range at normal RV Load (NM)	2,500	2,500	4,230
Throw weight (lbs.)	1,000	3,300	2,900
Guidance	Inertial	Inertial	Stellar/ Inertial

Source: IISS, *Military Balance 1982-1983*, U.S. Navy, Arms Control and Disarmament Agency, Congressional Budget Office, General Accounting Office.

* NOTE: This is in excess of the SALT II limit of 7 but is based on open source data which may be in error. Furthermore, SALT II is not a ratified treaty.

The immediate impact of Trident I centered on its most significant advantage, range. In order to cover the same range of targets in the Soviet Union, 16 times the ocean area could now be used. Not only does this complicate ASW efforts against a Trident I-equipped submarine to the point of making the SSBN force highly survivable for the near future, but it also complicates Soviet ballistic missile defenses (BMD). When ICBM silo positions and SSBN patrol zones limited by shorter range missiles are known or suspected, a BMD program could be devised concentrating only in sectors from which missiles are likely to arrive. Trident I makes the threat to the Soviet Union more nearly a 360° one. Trident I also lessened the need for overseas bases since patrol areas could now be relatively closer to the United States; thus, the loss of the Rota, Spain, SSBN facility had no significant impact on the Navy's ability to keep a required number of warheads on patrol. Trident I will be carried aboard the *Ohio*-class and 12 formerly Poseidon-capable SSBNs. The theoretical SSBN force strucure should have been as depicted in Table 5 at the end of FY-82.[11]

Table 5. SSBN Patrol Forces Early FY-83

	Number Subs	x Launchers Per Sub	x RVs Per Missile	= Sub Total	x Availability	= RVs On Patrols
Poseidon sub w/C3	19	16	10	3,040	55%	1,672
Poseidon sub w/C4	12	16	8	1,536	55%	845
Ohio w/C4	2	24	8	384	66%	253
Totals	33	544		4,960		2,770

Source: Author from previous data.

By using the delivery rates for SSBNs, outlined in Table 2, Table 6 shows the number of SLBM launchers in existence at the end of each fiscal year.

Table 6. Total SLBM Launcher Levels

	FY-82	FY-83	FY-84	FY-85	FY-86	FY-87	FY-88	FY-89
Poseidon sub s/C3	304	304	304	304	304	304	304	304
Poseidon sub w/C4	192	192	192	192	192	192	192	192
Ohio w/C4	48	72	120	144	192	216	240	264
Totals	544	568	616	640	688	712	736	760

Source: Author, for end of each FY.

From the totals in Table 6 it should be noted that as early as FY-86, the United States will exceed the SALT I ceiling of SLBM launchers. The United States was allowed to exceed the ceiling by trading in either older ICBM or SLBM launchers on a one for one basis up to a 710 maximum. According to the *FY-83 Arms Control Impact Statements*, the United States will have 832 launchers in FY-86.[12] This must mean that in addition to Poseidon and Trident I launchers outlined above, 144 launchers aboard 9 old Polaris boats are still being counted under SALT. This must also mean

that despite the decommissioning of one SSBN and the planned conversion of eight others to SSNs, their launchers remain SALT I accountable. Assuming that this problem will be solved, the SALT I limit of 710 SLBM launchers will be exceeded with the ninth *Ohio*-class submarine in FY-87.

Although not ratified SALT II adds another factor. If the United States replaces Minuteman launchers with new MIRVed MX missile launchers, the SALT II MIRV ICBM/SLBM launcher limit of 1,200 will be reached in FY-86 or perhaps earlier. Therefore, only 4 or 6 (depending upon MX decisions) total *Ohio*-class submarines can be built without exceeding SALT II MIRV launcher limits.[13]

In addition to Trident I, *Ohio* has been built to handle a new generation of SLBM with a height of up to 44 ft., width of 83 inches, and 115,000 lbs. of launch weight.[14] Termed the Trident II, this new missile does *not* yet exist.

The desire for a new generation of missile again comes from ULMS where the original goal was a missile with a 6,000 mile range. *Ohio*'s missile tubes could handle a missile capable of this range. However, range could be kept the same and improvements made in accuracy or warhead yield, or some combination of all three. Therein lies the problem with Trident II and the source of its lack of full congressional support in the past.[15] The case for longer ranges in Trident I was easy to understand because they supported survivability. If survivability is thus now essentially assured, it would be logical to concentrate on accuracy and yield. Enough improvement in these areas could give a whole new dimension to the SLBM, enhanced targeting flexibility across the full spectrum.

Hence, Trident II has not been fully supported by earlier administrations or Congress. A Trident II missile does not yet exist but remains in research and development (R+D). All earlier attempts to fund Trident II as a super hard target counterforce capable weapon have been denied by Congress. Trident II was held up while the possibility of saving money by developing one common Air Force and Navy missile was investigated. A common missile to take the place of Trident II and MX may have seemed logical to budgeteers, but it was finally dropped in October 1981 when President Ronald Reagan announced his desire to develop both missiles.

A Trident II (D-5) missile will probably possess increased accuracy and higher yields and increased range. It will thus be, by design, inherently a more flexible weapon including the ability to be used as a super hard rarger counterforce (counter silo) weapon.[16] The earliest Trident II might become operational is 1989, although with additional funding it could be earlier. Warhead selection may be a problem since the Thresbold Test Ban Treaty (TTBT) limits underground warbead testing to yields less than 150 KT. This treaty has not been ratified but is being observed. If the United States wants substantially to improve current RV yields and test a full RV, the TTBT may have to be renegotiated or the status of this unratified treaty modified. New warheads for the MX are also required and it is possible that a common design will be used.[17]

Trident II has had an impact on plans to upgrade Trident I accuracy. Current accuracy is probably sufficient to limit unwanted collateral damage. Even if accuracy were improved, Trident I RVs do not presently have the yield for counter silo targeting. A new Trident I warhead could, however, be designed with fewer RVs of sufficiently higher yield to allow counter silo targeting.

Another part of the Trident missile program is contained in the Air Force's

Advanced Ballistic Reentry Vehicle (ABRV) Systems Program. ABRV is designed to provide a new warhead for MX and Trident II if needed. RV survivability has been questioned in the face of legally existing Soviet BMD. To improve RV survivability R+D was commenced on varying Maneuvering Reentry Vehicle (MaRV) programs. MaRV could evade BMD and still retain accuracy. A MaRV termed the MK-500 Evader was tested for compatibility with Trident I. But MaRV is in R+D and could not be operational until the 1990s.

Alternatives

The *Ohio*-class submarine is controversial because a smaller number of new submarines is able to do the same job as a larger number of previous ones. Thus, the loss of even one has a significantly greater percentage of effect on total force capability. This "too many eggs in one basket" controversy is not limited to SSBN procurement nor even to US naval forces.

The decision to progress to larger more capable submarines (*Los Angeles* and *Ohio*) was debated within the Navy and outside. The Navy has often argued that larger submarines are more survivable and cost effective. In this day of limited defense dollars with a need to upgrade conventional and strategic forces, the Trident System probably is the best buy for total force improvement. Yet some critics favor abandoning *Ohio* totally; others favor completing only a few, and many favor larger numbers of smaller submarines.

The Center for Naval Analyses (CNA) has completed three studies since 1970 on this aspect of the Trident controversy. They have concluded that, due to economies of scale, large *Ohio* submarines with Trident II missiles are the best buy for the money.[18] Specifically, *Ohio*/Trident II is better than reopening the Poseidon SSBN program. CNA did concede, however, that modest savings could have been realized if a smaller reactor had been used. In all, they recommended the purchase of 10 *Ohio*-class submarines with Trident II.

The Congressional Budget Office (CBO) concurred with some of these findings.[19] They considered numerous possible options including new construction of 16-tube Poseidon SSBNs. Interestingly, this was the most expensive alternative of those they considered. Essentially the problem is that reverting to submarines with less than 24 tubes results in lower individual ship costs but higher overall costs due to the number of ships required, increased manpower, training costs, and since the Poseidon-capable submarines can only average a 55 percent on-station availability.

The CBO study concluded that a force of 9 *Ohio*-class SSBNs equipped with Trident II could provide essentially the same level of destruction at sea, on patrol, as was carried in the past by 41 Polaris/Poseidon boats. CBO called the Polaris/Poseidon level 431 Equivalent Megatonnage (EMT) or that carried by approximately 2,000 MK-4 RVs (used for illustrative purposes). They assumed that Trident II would carry at least 13 MK-4 RVs or a different warhead with at least the same megatonnage.

Furthermore, CBO concluded, if a decision was made to increase the on-patrol EMT totals to higher amounts, then Trident II-equipped *Ohio* submarines were about as expensive as other alternatives. If the 431 EMT level were the goal, then a mixed force of 10 *Ohios* and 7 new-design Poseidon ships with 24 tubes armed with Trident I missiles would be $2 billion cheaper.

Any desire to build SSBNs smaller than *Ohio* must consider the possibility that patrol availability of 66 percent is likely not to be achieved. The *Ohio*'s design features are a major factor in improving this rate of 55 percent aboard Poseidon ships. Acoustical quieting is not likely to be nearly as successful. The decision to proceed on with Trident II as a super hard target counterforce weapon essentially ties the United States to *Ohio* hulls although Trident I might be made counterforce-capable with significant reductions in numbers of RVs. Table 7 summarized the CBO results using various submarine designs. CBO used the figures 2,000, 3,000, and 4,000 MK 4 RVs for each possible on-patrol force level. The on-patrol EMT has been calculated and provided. Ten *Ohios* were included where indicated since CBO felt they would be built anyway. Billions of dollars represent total procurement of all forces for that option. A slightly smaller 24-tube submarine which might be developed was termed the SSBNX.

Table 7. SSBN Alternative Costs
(Numbers of Submarines and Billions of FY-80 Dollars)

MK 4 Warheads on patrol	2,000	4,000	6,000
EMT Level	431	646	862
Ohio w/Trident II	9 *Ohio*	14 *Ohio*	18 *Ohio*
	$36	$53	$66
New Large 24 Tube	No new subs	4 SSBNX	9 SSBNX
SSBN + *Ohio*	needed for	10 *Ohio*	10 *Ohio*
w/Trident II	this option	$53	$65
Ohio w/Trident I	16 *Ohio*	24 *Ohio*	32 *Ohio*
	$35	$58	$80
New Design	7 New subs	15 New Subs	24 New Subs
24-Tube Poseidon +	10 *Ohio*	10 *Ohio*	10 *Ohio*
Ohio w/Trident I	$34	$53	$70
Existing Design	10 Poseidon	23 Poseidon	36 Poseidon
16-Tube Poseidon +	10 *Ohio*	10 *Ohio*	10 *Ohio*
Ohio w/Trident I	$38	$63	$85

Source: Congressional Budget Office

In the controversy over the numbers of submarines that need to be put to sea and to survive, some assumptions must be made about the capability of Soviet strategic ASW and the possibility of a much heralded breakthrough or further advances in ASW techniques and capabilities. This is an extremely sensitive and significant question since a wrong answer could make the sea-based leg of the triad as vulnerable as the fixed base ICBM leg. Can we afford not to be conservative and prudent in our strategy as in the past? On the other hand, if we assume the Soviets are better than they really are, we may be talking ourselves out of a perfectly adequate strategic system.

Despite the research and development which has gone on in this and other

countries, there is no known major breakthrough foreseen which will make the SSBN force on patrol subject to a near simultaneous preemptive attack by any nation. This point has been made repeatedly to Congress by knowledgeable, honest, and sincere naval officers who have access to vast amounts of technical and scientific data. Put simply, the 4,000 nm range given to Trident I requires too much ocean to be searched. Put another way, it is a big ocean and any single submarine is simply too small. But do we truly know the capabilities and potential of Soviet ASW?

What about backfitting the other 19 Poseidon-equipped submarines with Trident I? This question again appears to have been best answered by economics. It would cost an additional $4 billion which the Navy felt would be better spent on finally getting Trident II operational. Additional backfitting of Poseidon boats is an alternative but would likely need to be funded by loss of authorization for other important programs.

As late as September 1981, the Congressional Office of Technology Assessment investigated MX missile-basing alternatives including the possibility of using 4 encapsulated MX missiles carried on each of 51 diesel-electric or even nuclear-powered submarines.[20] We appear to be destined to continue the debate over *Ohio* and the Trident System since it *seems* logical that something should or could have been designed which would have been cheaper.[21] It seems obvious that, at this point *Ohio*-class submarines and Trident II missiles represent the best way to fund a sea-based strategic nuclear force which should be survivable into the next century. To understand this, one needs to analyze what the sea-based strategic nuclear force can, will, or should do.

Future of Trident

In order to develop the possible future uses of the Trident System, it will be necessary to evaluate first what it is exactly that has been bought. Combining the delivery data from Table 2, warhead characteristics from Table 4, and RVs on patrol methodology from Table 5, the following information has been derived. Table 8 projects the approximate numbers of the different types of SLBM RVs and their EMT on patrol by the end of each FY.[22] Although EMT is but one measure of effectiveness, it is easy to understand, can be constructed from unclassified data, and is useful in determining potential destruction of all type targets. EMT can measure the ability to conduct barrage attacks such as those which might be contemplated against mobile targets.

Prior to the Trident System, ten Polaris boats with A3 missiles and 31 Poseidon boats with C3 missiles would have put approximately 2,816 independently targetable RVs on patrol at any one time with an approximate EMT of 409.0. The CBO description of earlier Polaris/Poseidon patrol capability was that of the EMT of 2,000 MK-4 RVs (431.0 EMT). It appears that by FY-83, the Navy will have more RVs or more EMT on patrol at any one time than was ever possible before. Thus it appears that the Trident System has not only bought us a more survivable force for beyond the 1990s but it has bought us a more capable naval leg of the triad in the 1980s.

Under current US political-military doctrine, five essential requirements exist for the employment of strategic nuclear forces (SNF).[23] These are:

Table 8. SLBM Patrol Capabilities

	FY82	FY83	FY84	FY85	FY86	FY87	FY88	FY89
Poseidon MK-3s	1672	1672	1672	1672	1672	1672	1672	1672
Poseidon MK-4s	845	845	845	845	845	845	845	845
Trident MK-4s	253	380	634	760	1014	1140	1267	1394
Subtotals	2770	2897	3151	3277	3531	3657	3784	3911
MK-3 EMT	196.5	195.6	196.5	196.5	196.5	196.5	196.5	196.5
MK-4 EMT	236.5	263.9	318.6	345.7	400.5	427.6	455.0	482.3
Totals	433.0	460.4	515.1	542.2	597.0	624.1	651.1	678.8

Source: Author, for the end of each FY

1. *Flexibility*. The ability to respond to options in addition to planned ones in programmed computer software. The ability to exercise a limited nuclear option. The ability to respond tactically to directives received from the National Command Authority (NCA) during all phases of a nuclear exchange.

2. *Escalation Control*. The ability to use limited amounts of force and to be able quickly to terminate fighting at lesser levels of conflict.

3. *Survivability and Endurance*. The ability to survive attempted attacks and remain responsive to the NCA over a lengthy period.

4. *Targeting Objectives*. The ability to target and successfully engage the full range of possible objectives including opposing SNF, theater and conventional forces, leadership and control sites, and the industrial and economic base. Damage limitation against noncombatants should be attempted but damage is probably inevitable.

5. *Reserve Force*. A survivable strategic reserve force must exist and remain responsive to the needs of NCA. This implies the need for survivable enduring command, control, communications, and intelligence (C^3I).

How do the Trident System and existing Poseidon SSBN forces measure up to these requirements? Primarily, their strong suite remains survivability, endurance, and ability to constitute a strategic reserve force. The SSBN force remains essentially the most survivable and retainable force while on patrol. They carry sufficient stores to remain an enduring force. *Ohio* carries provisions for 90 days or 20 in excess of a normal patrol.[24]

As a fully capable strategic reserve force, the SSBN faces major problems with C^3I. These problems, however, are not unique to the Navy. C^3I is a problem with the air-breathing leg of the triad on an initial retaliatory strike and to a lesser extent with ICBMs.

Before or during an initial nuclear exchange, NCA can use a large number of existing methods of C^3I to transmit Emergency Action Messages (EAM) to deployed SSBNs.[25] This includes land-based transmitters, satellite links, airborne command posts or relay aircraft, and an emergency Rocket Communications System. New systems are being developed such as mobile transmitters, lasers, and Extremely Low Frequency (ELF) Systems.

Do present C^3I and planned improvements meet the requirements for surviving and enduring capabilities? Problems which need to be solved include the vulnerability of any fixed land or space facilities, the need to prevent limitations on their effectiveness to wartime countermeasures, and a reserve set of capabilities including their needed logistic support which could last in a hostile environment for as long as the SSBN could remain on patrol. C^3I systems need to be built which can themselves survive and assess the results of attacks, provide reliable data on own and hostile forces, aid the NCA wherever they might be, and relay instructions to a strategic reserve force which is both flexible in targeting options and timely in response. C^3I is needed to support the other two triad legs but it is also needed by the Navy if it is fully to meet the challenges of a fully capable strategic reserve force.

The Trident System has had a positive impact on improving the targeting capabilities and flexibility of the SNF. Trident I missiles are more accurate than Poseidon and deliver a slightly more effective amount of damage against soft targets. Increases against hardened targets do not yet reach levels where Trident I could be used as a counter-silo weapon. Table 9 summarizes the estimated effectiveness of Poseidon and Trident I RVs against targets where the highest measure of capability is 1.0.[26] Improved capability is largely due to greater yield and missile accuracy (between C3 and C4) and submarine navigation systems (between Poseidon and *Ohio* subs).

Table 9. SLBM Destruction Capabilities

	Soft Targets (Industrial) Economic, Airfields)	Moderately Hard Targets (Military)	Superhard Targets (Silos, Control Centers)
Poseidon sub w/C3	.4	.08	.03
Poseidon sub w/C4	.47	.26	.18
Ohio w/C4	.6	.3	.2

Source: Navy

Against soft targets, Trident I brought a modest increase in capability for causing damage. A substantial increase was obtained in capability against moderately hard targets, however, there are only a small number of these targets. Trident I did bring a significant increase in capability against super hard targets but still not enough to be able to be an effective force against them.

If the Navy is to be able to respond to the full range of targets either as a retaliatory, damage-limiting, denial of victory, or strategic reserve force, a new missile and warhead must be made operational. As a hedge against any possible future advances in Soviet ASW, it appears that Trident II will have increased range. Trident II will need more yield and greater accuracy.[27] Not all missiles deployed on a submarine need have the same warheads. Single RVs or a minimal number of MIRVs can be carried for super hard targets. Barrage-capable warheads with more MIRVs might be useful against mobile targets. Variable yields might be one option which would give the Navy the ability to respond in a very flexible manner.

A problem in fully reaching the degree of flexibility required by current strategic planning is the inability of SSBN fire control systems to respond to NCA targeting of time-urgent targets. In the past, only packages of targeting options could be rapidly changed. A true flexible capability must include the ability to rapidly modify the destination of individual SLBM RVs and fire these missiles against time-urgent targets. This problem appears to be solvable perhaps by direct input of data into each computer in a downlink prior to launch or as was planned for MX.[28]

Although specific patrol locations for an individual SSBN are not known to ASW forces of the Soviet Union, any requirement to fire one or a partial salvo might reveal the general or specific location of the submarine. Firing a missile is an observable event which could substantially reduce the portion of the seas which hostile surveillance or ASW forces would need to search in any attempt to find the SSBN prior to his use of remaining missiles. This factor might even allow for the Soviet Union to barrage an area with ICBMs equipped with nuclear depth bombs.

Keeping this in mind, the submarine must, therefore, have the extra quiet speed that *Ohio* provides in order quickly to vacate a previous launch area and return to the protection of the vast ocean space. Attempts to limit ships' size in future buys must be resisted. By their very nature, SSBNs are not the best suited to *limited* nuclear options if they expect to remain as survivable as they are on undetected patrol.

Warhead upgrading is an area receiving attention which will assist in both flexible targeting and survivability of the individual RV. It is necessary to have RVs capable of engaging the full range of targets which have passive defenses and those which are actively defended. BMD advances by the Soviet Union are not fully understood in the West and probably are the subject of considerable Soviet disinformation. MaRV is a hedge against Soviet BMD advances and if operationally capable, will ensure penetration with comparable accuracy, admittedly with higher cost and payload penalties. Limitations on collateral damage are as possible as increases in RV accuracy.

The SSBN force has always been capable of carrying out a mission which would include punishing any nation which has committed aggression against the United States. It has always been able to strike at industrial-economic targets and military targets in either a punishment role or in support of the air breathing leg's attempt to succeed in their mission. If this is the task which the Navy is going to have, then the purchase of 9 or 10 *Ohio*-class submarines and the development of a new Trident II with more RVs should suffice. The purchase of 16 *Ohios* armed only with existing Trident Is could also do the same job with slightly less cost; it could satisfy critics who fear for pre-war SSBN vulnerability due to reduced aim points. Sixteen *Ohios* with Trident II will provide us with the needed capability should we have to rely more on the sea-based leg of the triad.

The highest levels in government are now deciding on the exact role which the SSBN force is to be assigned into the next century. From this decision, force acquisition is being made. If the Navy is to participate fully in a warfighting strategy which denies an enemy his ability to achieve victory, then Trident II needs to be countersilo capable. If the strategic reserve force is to be able to target reuseable Soviet cold-launch silos and command centers, it needs to have accurate and high yield RVs.

What role should the Navy play in overall SNF posture? Can the air-breathing leg be developed which is a viable force with a realistic ability to deliver warheads on targets? Can ICBM vulnerability solutions be funded? Should we draw down to a dyad or even a monad? Can the Navy do it all?

It can certainly be shown that counterforce capable Trident-II equipped *Ohio*-class submarines could be fielded with an equal number of deliverable RVs as now are contained in Titan, Minuteman, and the proposed MX fields. Surely enough SSBN/SLBMs could be built to equal the number of deliverable bomber warheads. Most likely a case could be made for a large Navy force which could put all these warheads on patrol more cheaply than the current triad method. Such an approach has the appeal of making all that Soviet expense in achieving a countersilo ICBM force and their massive antiaircraft defenses seem like it was not worthwhile. Is this wise, however?

If the national strategic plan were punishment of an aggressor, the Navy could probably do it cheaper. But denial of victory is the preferred strategy, with punishment as an alternative. Can the Navy do that or can any single service? Denial of victory implies a much larger SNF than is currently possessed by this country. It implies solutions to problems in each leg of the triad such as C^3I, rapid retargeting, accuracy, and different yields. The latter three appear to be possible but is C^3I? It is doubtful that any *one* Service ever could be able to provide a force capable of meeting *all* the requirements of our national strategy.

If the sea-based leg were beefed up at the expense of ICBM or bomber programs, might not this allow the Soviets to rechannel resources into BMD or a strong enough Navy to support long-range independent strategic ASW?

Clearly decisions need to be made and policies implemented. Force acquisition levels need to be finalized. The expired and unratified SALT limitations will be exceeded in the currently funded building program. Testing full-scale D-5 warheads may result in the unratified TTBT being exceeded. Decisions need to be made on whether these treaties will be adhered to since none are technically in force.

The current amounts of SLBM capability on patrol could be increased further by backfitting more Poseidon-capable submarines with Trident I. This may be desirable depending on the future of MX and the manned bomber force. Despite the realities that hardware acquisition often precedes final strategy decisions, we still have the option with the Trident System to decide doctrine and straregy first and procure weapons later.

In the meantime, until all decisions are fully made, it is the author's view that the Trident II missile *must* be developed. Long lead times for *Ohio* submarines should likewise be funded. The sea-based strategic force is currently capable of fulfilling its assigned missions and will develop a capability exceeding that of the past. If the Navy is given the task of more fully carrying out the new national strategic doctrine which deemphasizes the other two legs of the triad, strategy will need to be changed and funding priorities adjusted.

NOTES

1. Norman Polmar and D.A. Paolucci, "Sea Based 'Strategic' Weapons for the 1980s and Beyond," US Naval Institute *Proceedings*, May 1978, pp. 100-101.

2. Polmar and Paolucci, p. 103; Thomas S. Burns, *The Secret War for the Ocean Depths: Soviet-American Rivalry for Mastery of the Seas* (New York: Rawson Associates, 1978), pp. 242-243. Unexpected support for ULMS came from the Members of Congress for Peace Through Law. This group favored sea-based missiles over ICBMs with Antiballistic Missile Defense.

3. Elmo R. Zumwalt, Jr., *On Watch: A Memoir* (New York: Quadrangle, 1976), pp. 152-155. Adm. Zumwalt, then Chief of Naval Operations, says that he was pursuaded to move up from the 35,000 horsepower reactor on the *Los Angeles* class after he met with a board of submarine commanders. They argued that the extra power would be beneficial in the event of a major casualty and also that it would allow for extra speed useful in evading any trailing antisubmarine warfare forces. It appears that the ability to install a large sonar system was a bonus to *Ohio's* size and not a driving factor.

4. David T. Leighton (Assistant to the Director of Naval Nuclear Propulsion Programs), "Statement" (29 October 1979). US Congress, House, Committee on Armed Services, Seapower and Strategic and Critical Materials Subcommittee, *Submarine Alternatives Study*, Hearings (Washington: US Govt. Print. Off., 1980), p. 139.

5. Funding came within 2 votes of being cancelled. See Zumwalt, pp. 157-163 for a good recollection of the drama of this vote. Professor George B. Kistiakowsky has stated that President Nixon was able to obtain the crucial vote of Senator John Stennis by convincing him that Trident was only a SALT bargaining chip. See US Congress, Senate, Committee on Foreign Relations, *Perceptions: Relations Between the United States and the Soviet Union* (Washington: US Govt. Print. Off., 1979), p. 350.

6. Taken from Rick Maze, "Her Mission is Peace, Bush Says of *Ohio*," *Navy Times*, 23 November 1981, p. 2.

7. Constructed from data in US Congress, General Accounting Office, *Alternatives to Consider in Planning Integrated Logistics Support for The Trident Submarine*, LCD-79-415 (Washington, 28 September 1979), p.7.

8. David Baker, "Ramifications of The Trident Programme," *Jane's Defence Review*, (1981), p. 27.

9. Adapted from data in the following unclassified sources; US Congress, House, Committee on Armed Services, Seapower and Strategic Critical Materials Subcommittee, *Hearings on Military Posture and H.R. 2970 and H.R. 2614* (Washington: US Govt. Print. Off., 1981), pt. 3, p. 155; International Institute for Strategic Studies, *The Military Balance 1982-1983* (London: 1982), p. 113; US Arms Control and Disarmament Agency, *Fiscal Year 1983 Arms Control Impact Statements* (Washington: US Govt. Print. Off., 1982), pp. 39, 40, 387, 388; US Congress, Congressional Budget Office, *The US Sea-Based Strategic Force: Costs of the Trident Submarine and Missile Programs and Alternatives* (Washington: US Govt. Print. Off., 1980); US Congress, General Accounting Office, *The Navy's Submarine Launched Ballistic Missile Force is Highly Ready*, LCD 78-429A, Washington, 21 December 1978, p. 47.

10. US Dept. of the Navy, Trident Systems Project Manager, "Trident Fleet Pitch, As of 9/80," unpublished briefing to accompany slide presentation, provided by PM2-112, 1 October 1981, slide 30, p. 37.

11. The numbers of RVs normally carried on the Poseidon C3 missile was to have been changed. The plan to change RVs was mentioned by VAdm. John G. Williams, Jr., Deputy Chief of Naval Operations for Submarine Warfare, "Statement," US Congress, House, Committee on Armed Services, Seapower and Strategic Critical Materials Subcommittee, *Hearings on Military Posture and H.R. 2970 and H.R. 2614* (Washington: US Govt. Print. Off., 1981), pt. 3, p. 156. For the purpose of Table 5, 10 RVs per missile will be assumed.

12. *Fiscal Year 1983 Arms Control Impact Statements*, p. 37. Page 34 says only 8 are still accountable. On page 38, none are listed in the cumulative totals. According to the press, the Navy is having to "deactivate" the SSBNs which were converted to SSN in order to remain within SALT I limits. See Nile Lathem, "Navy de-fanging missile sub," *New York Post*, 10 May 1982, p. 3; "Navy Set to Decommission 9 Ships, 3 Subs in FY '83" *Navy Times*, 20 September 1982, p. 36.

13. Today the United States has 550 MIRVed ICBMs and 520 MIRVed SLBMs. The sixth *Ohio* will bring the United States up to 1,190. If the 40 MIRVed MX missiles are deployed in old non-MIRVed Minuteman II silos, then only four *Ohios* can be built under SALT II limits. It is assumed in these calculations that all decommissioned SSBN launchers do not count.

14. *US Sea-Based Strategic Force*, pp. 22-23. The cost of modifying each *Ohio* to actually carry a new missile has been estimated at less than $100 million per ship.

15. Funding for Trident II has consistently been held up by Congress. See US Congress, Congressional Budget Office, *SALT II and the Costs of Modernizing US Strategic Forces* (Washington: US Govt. Print. Off., 1979), pp. 8, 19.

16. These requirements were recently discussed by Richard D. DeLauer, Under Secretary of Defense for Research and Engineering at a two-day meeting in Bedford, Massachusetts jointly sponsored by the Air Force Electronics Systems Division and Mitre Corporation. See Clarence A. Robinson, Jr., "Pentagon Backs Strategic Modernization," *Aviation Week and Space Technology*, 26 October 1981, p. 49.

17. D5 and MX warheads may or may not be identical. See "AVCO Multiple Warhead Selected for Use on MX," *Navy Times*, 15 February 1982, p. 23. According to "MX Missile May Get More Powerful Warhead," *The New York Times*, 10 October 1981, p. 26, the ABRV was to have a 600 KT warhead. The Trident II warhead has been described as either a 9 RV MK-12A system capable of 4,000 nm range or a 14-16 RV MK-4 system. See Clarence A. Robinson Jr., "Congress Questioning Viability of MX ICBM," *Aviation Week and Space Technology*, 22 March 1982, p. 18. This article states the ABRV has a 300 KT yield for each RV.

18. Center for Naval Analysis, *Annual Report 1978* (Alexandria, Va.: 1978), pp. 12-13.

19. *US Sea-Based Strategic Force.*

20. US Congress, Office of Technology Assessment, *MX Missile Basing* (Washington: US Govt. Print. Off., 1981).

21. Two recent and typical arguments for larger numbers of small cheaper snbmarines (diesel-electric) are Michael MccGwire, "Soviet-American Naval Arms Control" and Richard L. Garwin, "The Shape of Future US Naval Forces," in George H. Quester, ed., *Navies and Arms Control* (New York: Praeger, 1980), pp. 73-74, 77, 89-92, 142-143, 153.

22. EMT = (number of RVs) × (megatonnage of individual RV)$^{2/3}$

23. Harold Brown, Secretary of Defense, *Department of Defense Annual Report Fiscal Year 1982* (Washington: US Govt. Print. Off., 1981), pp. 40-42.

24. "Trident Fleet Pitch," Slide 15, p.20.

25. For a revealing assessment of the various methods of C^3 see, Owen Wilkes, "Command and Control of the Sea-Based Nuclear Deterrent: The Possibility of a Counterforce Role," *World Armaments and Disarmaments SIPRI Yearbook 1979*, Stockholm International Peace Research Institute (London: Taylor and Francis, 1979), pp. 394-398, 401-406. See also *MX Missile Basing*, pp. 173-174, 290-293.

26. Adapted from vugraph presented by RAdm. Powell Carter, Jr., Director, Strategic and Theater Nuclear Warfare Division, Office of the Chief of Naval Operations, in his 5 March 1981 statement contained in, *Hearings on Military Posture and H.R. 2970 and H.R. 2614*, pp. 128-129. Mr. Richard Perle, Assistant Secretary of Defense for International Security Policy provided the Trident II "hard" target kill potential to Congress on 23 February 1982. His data probably equates to "super hard" in table 9. The potential was approximately 85. See US Congress, House, Committee on Armed Services, *Hearings on Military Posture and H.R. 5968, Strategic Programs* (Washington: US Govt. Print. Off., 1982), pt. 2, p. 75.

27. These capabilities are currently achievable. *MX Missile Basing*, pp. 22, 199-208, 303, concluded that no significant degradation of accuracy would be present in a sea-based variant of MX when compared to the traditional land-based.

28. US Congress, General Accounting Office, *Countervailing Strategy Demands Revision of Strategic Force Acquisition Plans*, MASAD-81-35, Washington, 5 August 1981, p. 37.

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The History Department of the United States Naval Academy will sponsor its sixth Naval History Symposium on September 29-30, 1983. The Symposium is seeking papers on all topics relating to naval and maritime history. Proposals should be sent to Assistant Professor Daniel M. Masterson, History Department, U.S. Naval Academy, Annapolis, Md., 21402. The deadline for proposals is April 1, 1983.